PATENT SPECIFICATION

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International Classification:—B61f, B62d, B66c.

COMPLETE SPECIFICATION

Improvements in or relating to Chassis for Road and like Vehicles

We, RHEINMETALL AKTIENGESELLSCHAFT, a German Company of Rather Strasse 110, Dusseldorf, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

The present invention relates to chassis for vehicles. The vehicles have a variable overall track and may be suitable for use on roads, open country or rails. The expression "overall track" is intended to mean the separation between the two most widely separated wheels of the vehicle, the separation being measured in a direction perpendicular to the direction of motion of the vehicle.

It is an object of the invention to provide an improved vehicle having a variable overall track which offers advantages over known vehicles having variable overall tracks.

According to the present invention, a vehicle chassis having a variable overall track comprises a chassis frame, at least two trucks whose positions relative to the frame can be altered to alter the overall track of the vehicle and of which the wheels form part of the complement of wheels on which the vehicle moves, and, for each truck supporting means connecting the truck to the chassis frame and which can be adjusted to produce said alteration of the position of the truck relative to the chassis frame, each truck being connected to its corresponding supporting means in such a way that it can turn relatively to its supporting means about a vertical axis.

The term "truck" is intended to mean a carriage having at least a pair of wheels, the wheels may be revolving skids or the like or rail wheels and they may be rubber-tyred or operate endless tracks.

The drive and steering of the vehicle can be arranged in a variety of ways.

In the case of small vehicles and a good travelling surface, for example, the vehicle may be driven by driving one of the trucks only. This may be especially advantageous when cheapness is essential. On the other hand, several or all of the trucks may be designed for being driven when the condition of the travelling surface requires it, or when particularly good and quick manoeuvrability of the vehicle is desired.

The steering may be dealt with in like manner, that is to say that the steering mechanism may be designed so that each truck can be steered independently, or all the trucks steered simultaneously.

When the vehicle is travelling normally, the supporting means are locked relatively to the chassis frame by known locking means to prevent undesirable movements of these components relatively to one another. In the simplest case, said locking means may be a staple bolt or the like, inserted and removed manually, electromagnetiically, pneumatically or hydraulically.

The supporting means may be arms pivotally connected to the chassis frame and the swivelling of the arms to produce a variation of the overall track may be carried out in a variety of ways.

The simplest method—which, however, can be performed only when the chassis is standing still—consists in first lifting the chassis frame, or placing it on suitable supports, to hold it off the ground. Said lifting of the frame can be carried out with the aid of known lifting devices, such as hydraulically or pneumatically operated jacks which are advantageously permanently provided on the chassis frame. The carrying arms are then unlocked and by hand or mechanical means (such as pneumatically or hydraulically operated working cylinders) swivelled out until the desired new overall track has been achieved. The carrying arms are then locked again, the

chassis frame is lowered to the ground and the chassis can now once more be operated with the changed overall track.

This method of adjustment will be used mainly when the chassis is not loaded, or when the load is so distributed that the raised frame cannot tip over. However, in many cases it will be found useful in this connection not to raise all carrying arms at the same time but singly, that is to say successively, and to proceed for the track variation in like manner.

Another, particularly simple and quick way of varying the overall track, when the vehicle is at a standstill and the supporting means are in the form of rotatable arms, may be followed when all the trucks are driven : In such a case it suffices to turn in the wheels of the individual trucks tangentially to the turning circle of the relevant carrying arms, to unlock the carrying arms and then to engage the drive of the truck for as long as is needed to achieve the desired adjustment. When the carrying arms have been locked again and the steering has been returned to the forward position, the vehicle is again ready for operation with the new overall track.

In a modification of this method the trucks can first be set tangentially to the turning circle of the rotatable carrying arms, which latter are then swivelled manually or mechanically until the desired variation has been achieved. In this case, it is of course, not necessary for all trucks to be adapted to be driven.

Another method of adjustment—which has the additional advantage that it can be carried out while the vehicle is travelling—consists in setting the trucks for the new overall track by suitable steering operations or movements.

This method can likewise be carried out in a variety of ways. In one case opposite locks are given only to the two front trucks (as seen in the travelling direction) by suitable steering mechanism so that during the forward travel these trucks, according to the wheel position, run outwardly (wider overall track) or inwardly (narrower overall track). While this is taking place, the other trucks remain set for straight ahead movements so that, for the moment, the separation between them remains unchanged. As soon as the front trucks are set at the desired separation, they are reset for forward travel, and their rotatable carrying arms are locked with the chassis frame, as described hereinbefore.

The variation of the separation between the rear trucks is carried out in an analogous manner, except that the chassis points in the opposite direction so that the rear trucks are then forward in the travelling direction.

After the carrying arms have been locked, the chassis can also in this case be used like any other motor vehicle for the usual operation on roads or work, by steering the front trucks or all trucks, which are now set for the new overall track.

When the trucks are mounted on pivoted arms it is, of course, by no means necessary to carry out the adjustment in two stages, as described. Instead all trucks can be adjusted for their desired new positions simultaneously, that is to say, with the chassis pointing in one travelling direction only, provided it is ensured that the steering is appropriately operated or the steering mechanism is suitably designed.

By way of example, embodiments of the invention in which the trucks are connected to the chassis frame by rotatable arms, will now be described with reference to the accompanying drawings in which :

Fig. 1 is a diagrammatic plan view of a chassis adjusted for a narrow overall track;

Fig. 2 shows the chassis of Fig. 1, after having been adjusted for a broad overall track ;

Fig. 3 shows a chassis similar to Fig. 2, but having additional road wheels;

Fig. 4 is a plan view of a chassis, adjusted for travelling along an embankment, quay wall or the like ;

Fig. 5 shows a special application of the chassis illustrated in Fig. 4, except that a chassis with a 3-truck support is used ;

Fig. 6 shows the chassis of Fig. 5, in a position for forward travelling ;

Fig. 7 shows in side elevation the chassis of Fig. 1, with a chassis frame adapted to be raised and lowered, shown here in the raised condition ;

Fig 7A shows the chassis of Fig. 7, as seen from underneath ;

Fig. 8 shows the chassis of Fig. 1 and illustrates the method of adjusting the separations between the trucks by the tangential positioning of the trucks ;

Fig. 9 is a plan view of a special chassis comprising two separate chassis frames connected together one behind the other, in the manner of a tractor and trailer ;

Fig. 10 is a plan view of another special type of chassis, especially for transporting heavy loads, having two separate chassis frames, connected together by means of a bridge ;

Fig. 11 is a diagram of the steering and driving mechanisms for the trucks ; and

Figs. 12 to 14 are a plan view, a side elevation and a front elevation respectively of a chassis embodying the invention, as used on mobile slewing cranes.

As can be seen from Figs. 1 and 2, the basic structure of the chassis embodying the invention is a chassis frame 1, assembled from box sections, for example,

which form the platform or the load-carrying surface or is used for the attachment or connection of a superstructure of any desired kind. Two pairs of carrying arms 3, 3' adapted for pivoting are connected with this frame through their pivots 2 and said carrying arms serve as carriers for two-wheeled trucks 4 of any desired kind, for example having pneumatic-tyred wheels. The trucks 4 are adapted to swivel in the head portion of the carrying arms about the axle 5.

Steering and drive of the trucks may be designed in a variety of ways and one, or several, or all trucks may be driven, according to the individual requirements. The same principle may be applied to the steering, that is to say, the trucks may be adapted for being steered singly, in pairs, or all together.

As will be readily understood on comparing Figs. 1 and 2, the pivoting of the carrying arms 3, 3' in the direction indicated by the arrows 6 enables the overall track of the chassis to be varied to any desired value within a wide range.

A particularly advantageous broad-track position is shown in Fig. 2; it affords an especially high and almost constant stability in four directions, that is to say safety of the chassis from tipping.

When it is adjusted for a narrow overall track, the chassis takes up relatively little space when viewed broadside, as shown in Fig. 1. This fact enables it to be used like any normal vehicle even in unfavourable travelling conditions, such as in narrow streets and in tight bends. This is particularly true when all trucks are steered concurrently.

The connection of the trucks 4 to the carrying arms 3, 3' and their steering mechanism is advantageously designed so that the trucks can swivel about their pivots 5 through any desired lock. By steering through 180° from any given position, the vehicle can be made to travel in the opposite direction, while the direction of wheel rotation remains the same; in this manner the reverse gear, or special reverse clutch for the trucks drive, becomes unnecessary.

While the vehicle is travelling, the carrying arms 3, 3' are fixed with respect to the chassis frame 1 through locking means of known type, for example staple bolts 7, so that the frame and the carrying arms form a practically rigid unit.

To vary (for example, to increase) the separations between the pairs of trucks, the locking means 7 is first undone; this can be done from a steering bridge located centrally (for example on the platform 1) with the aid of electromagnetic, pneumatic, hydraulic or other means.

The next step consists in pivoting the carrying arms 3, 3' outwards in the direction indicated by arrows 6, which can be done while the vehicle is standing still or is travelling, in the following manner:

Variation of the Separation between the Pairs of Trucks with the Chassis Standing Still.

The procedure may be as shown in Figs. 7, 7a or 8.

In the example according to Figs. 7 and 7a, there are provided in the four corners of the chassis frame 1 mechanical, hydraulic or pneumatic jacks 8 which can be operated singly or concurrently. With the aid of these jacks the frame 1 is first raised high enough to lift the trucks 4 off the ground. The above-mentioned locking means 7 of the carrying arms 3 and 3' is then undone, and the carrying arms are adjusted manually or mechanically (for example by means of pneumatic cylinders) for the desired separation (shown in broken lines in Fig. 7a). The carrying arms are then locked again, the chassis frame is lowered, and the chassis, adjusted to have the new overall track, is again ready for the road.

It will be found advantageous to connect the jacks 8 to the frame in a manner such that it has a maximum of supporting area to rest on when the frame 1 is in the raised position. Alternatively, as mentioned hereinbefore, the carrying arms can be raised and pivoted singly and successively; this will be found particularly useful when the adjustment of the positions of the trucks is to be made while the vehicle is loaded.

Another method of varying the separation between the trucks is represented by Fig. 8. In this case, before or after having unlocked the carrying arms 3, 3', the trucks are placed tangentially to the pivoting circle of the carrying arms by suitably operating the steering (as shown by the broken lines in Fig. 8) and the carrying arms are then pivoted in the direction indicated by arrows 9 until the desired separation has been achieved. In the case of driven trucks the simplest manner of pivoting the carrying arms is by engaging the truck drive so that, when all trucks are of the driven kind, they are simultaneously adjusted for the new overall track.

In the case of idling trucks, on the other hand, the pivoting of the carrying arms is performed manually or, with large vehicles, mechanically. As soon as the carrying arms have been locked, the chassis is once more ready for operation with the new overall track. If the position of the trucks is not changed, and the drive mechanism is engaged, the vehicle will be circling about the centre of the chassis, that is to say it will perform movements which are desirable, for example, for a mobile crane having

no slewing motion of its own. From this position the chassis can, of course, be used in traffic like any other motor vehicle by being suitably steered.

Varying of the Separation between Pairs of Trucks while Chassis is Travelling.

Several methods of varying the positions of the trucks while the vehicle chassis is travelling normally are described hereinafter with reference to Figs. 1 and 2. At first, let it be assumed that all trucks are adapted to be steered.

The procedure in this case is first to uncouple the locking of the carrying arms 3, 3' and then to steer all four trucks, with the vehicle moving, either jointly, in pairs or, if desired singly, in opposite directions as indicated by the broken lines in the top portion of Fig. 1. During this steering manœuvre the trucks will diverge outwardly to a certain extent depending on the lock they have been given and take the carrying arms with them until the steering is returned to the forward direction. After the travelling arms have been relocked on the frame, the vehicle is once more ready for normal use with the new overall track (Fig. 2) by operating the steering in the usual manner, that is to say by steering adjacent trucks in the same direction.

The slewing of the carrying arms through steering can alternatively be performed in two stages by first steering in opposite directions only the front trucks (seen in the travelling direction (see Fig. 1, top half), while the rear trucks remain positioned for travelling straight ahead. The carrying arms 3 of the front trucks are then locked, the drive of the chassis is put in reverse gear and, while this opposite travelling direction is maintained, the other two carrying arms 3' are slewed in the appropriate direction.

For example, in case the trucks associated with the carrying arms 3' are not provided with driven axles but with idling axles, the adjustment of the positions of the trucks can be performed in analogous manner, except that, in transit, the carrying arms 3' must be slewed with the aid of special devices, such as pneumatic cylinders or other power-driven means, to enable the idling axles to adjust themselves to the desired positions.

Fig. 3 represents another variant of a chassis embodying the invention but which is distinguished from the designs described above in that the chassis is further provided with an auxiliary bogie 10. This auxiliary truck, which may be of any desired design, carries part of the total load so that the ground pressures on the other trucks are correspondingly reduced.

Composite chassis, more especially designed for carrying especially heavy loads, are represented by Figs. 9 and 10.

In Fig. 9 the composite chassis comprises two separate chassis 11 and 12, connected together by an articulated cradle as used for trailers. One of these chassis frame has two slewable carrying arms 13, 13' with bogies 14, 14' and an axle 15 attached in usual manner. The other chassis frame, provided with slewable connected carrying arms 16, 16', is coupled with the chassis 13 by means of a cradle connection 17, the cradle comprising, for example, a slewing race 18 and a slewing bearing 19. The separations between the foremost trucks and the trailing trucks can be varied in the manner described above and the overall track of the composite vehicle will be the separation between the most widely separated pair of trucks, if the pairs are not separated by the same distances.

For special purposes, particularly for extremely heavy duty operation, a composite chassis can be designed as shown in Fig. 10. In this case two separate chassis frames, marked 20 and 21 as units, are connected together through a gimbal-mounted bridge 22 which carries the load, for example, a slewing jib crane superstructure not shown in the drawing. Each individual chassis frame 20, 21 has four carrying arms 23, 24 adapted to slew. In the position shown in Fig. 10, in which the arms are perpendicular to the direction of the vehicle, the arms are adjusted to provide the vehicle with the maximum overall track and therefore maximum stability. Narrowing the track is performed in the manner described above by slewing the carrying arms in the direction indicated by arrows 25 and 26 respectively. In narrowing the track the arms 26 on either side of the bridge 22 are moved towards each other. Since they must both be accommodated within the length of the bridge 22, they are kept as short as possible so that the length of the bridge need not be unduly great.

A chassis of particularly simple design is shown in Figs. 5 and 6. This has a chassis frame 27 provided with only two slewable carrying arms 28, the third support for the frame 27 being designed as a truck 30 capable of pivoting about an axle 29, but otherwise fixed to the frame 27. For small vehicles built along these lines it will suffice to adapt only the truck 29 to be driven, the other trucks merely being provided with steering devices. Fig. 6 shows this type of chassis in the expanded position, set for forward travelling. Fig. 5 shows an identical chassis in a particular position, in fact travelling along a slope, for example a quay wall. If, for example, a slewing jib crane superstructure is installed on the platform 27 of such a chassis the maximum radius

of the jib can be, as will be readily understood, utilised to a far-reaching extent.

The way in which the vehicle is positioned in such a case is shown in Fig. 4 for a chassis having four carrying arms. To increase the stability of the vehicle in this position, for example when it carries a crane, at least the carrying arms pointing rearwardly can be loaded with additional ballast weights which may advantageously be lodged in the actual carrying arms, that is to say, the carrying arms are made from box sections filled with baryta, concrete or scrap metal.

As to the design of the steering and drive mechanisms for the individual truck, there are, of course, numerous possibilities open to the designer. A drive mechanism is shown in diagrammatic form in Fig. 11. 3 (3′ respectively) is a carrying arm which is adapted for slewing by means of the hinged link 30 about the axles 2 on the chassis frame (not shown in this figure), as described above. In this case the steering mechanism consists of a bevel gear 31 which is connected with the steering mechanism and is in constant engagement with another bevel gear 32 which revolves about the axle 2 and merely has the function of an intermediate gear. The driving power thence goes via the bevel gear 33 and the shaft 34 to the pinion 35. The shaft 34 runs in bearing bushes 36 provided in the carrying arms 3. Bevel gear 35 meshes with a bevel gear 37 which latter is rigidly connected with a hollow spigot 38 serving as a swivel bearing for the swivelling cradle of the bogie 4. Thus, any manipulation of the steering lever or steering wheel is transmitted through the bevel or spiral gears to the swivelling bogie cradle, with the meshing gears 35, 37 at the same time acting as a reduction gearing.

The truck drive is designed in corresponding manner. The bevel gear 39, which can be coupled with the drive mechanism, meshes with a gear 40 which is adapted to revolve about the pivot axle 2 of the carrying arm 3. The driving power is then transmitted via the bevel gear 41, the shaft 42 and the bevel gear 43 to the bevel gear 44 which, in turn, drives the axle 48, and with it the truck, through the intermediate shaft 45 and the meshing bevel gears 46, 47. It will be understood that, alternatively, both wheels of the bogie can be driven simultaneously, which is advantageously made possible by fitting a differential gear in known manner. Since the intermediate shaft 45 can rotate freely in respect of the truck cradle, the hollow spigot 38 and the bevel gear 37, the steering and the drive can be operated quite independently of each other. The steering and drive mechanisms described above can, of course, be lodged inside the carrying arm 3 if the latter is a box section structure or the like.

To avoid the long driving chains with their multiplicity of engaging positions it is possible, for example, to combine the steering drive unit directly with the truck cradle. In such a case, the power unit is, for example, an electric motor or a pneumatic or hydraulic motor or working cylinder, which remains engaged for the duration of the steering motion or imparts a succession of short steering impulses to the truck cradle. When the steering unit is in the inoperative position, a braking or locking device is actuated to lock the truck cradle in respect of the carrying arm.

Finally, Figs. 12 to 14 represent a further example of a practical application of a chassis to which the invention relates, being used in conjunction with a mobile slewing crane, also called auto-crane. Also in this case the chassis, that is the undercarriage of the slewing crane, consists of a frame 1 to which four carrying arms 3, 3′ with cradle-mounted trucks 4, are pivotably connected by means of hinge links 2. In Fig. 14, the truck shown on the left is designed as a non-driven unit, whereas on the right at 49 a driven truck with an intermediately located differential gear 50 is arranged. Both trucks are fitted with jointed cross shaft axles. The main drive motor 51 is fitted on the undercarriage, 52 being the slewable superstructure having a jib 53 represented by its longitudinal axis. As is usual, the superstructure revolves on the ball-and-joint type slewing race 54.

In the collapsed position (indicated in Fig. 12 by solid lines) the crane can be driven like any conventional slewing crane not having the support of the carrying arms, and like any conventional motor vehicle, also when loaded, provided that the load moment, that is the weight of the load multiplied by the jib radius, does not exceed a certain value depending on the width of the track and the dead weight of the crane.

If a major load moment is to be taken up and the crane should remain able to travel under such load, all that is needed, in applying the invention, is to increase the separation between the trucks as described hereinbefore. With the carrying arms in the expanded position, that is to say in the broad-track position (indicated in Fig. 12 by the broken lines), a degree of stability is obtained which fully satisfies all practical requirements and, owing to the square shape of the frame 1 and the opening angle of the carrying arms being under 45°, is approximately equal in all four working directions. A similar degree of stability has hitherto been obtained with

mobile slewing cranes only by using four far-reaching collapsible supports, and even then, as a rule, only when the possibility of propelling the crane under load was sacrificed. On the other hand, as mentioned, a crane fitted with a chassis according to the present invention can be driven in any desired direction in the expanded position without difficulty and even under the most unfavourable operational conditions, that is to say with a heavy load up and with a considerably derricked jib.

As will be immediately clear to the expert, the chassis design of the present invention is so unusually versatile that all such possible applications cannot conveniently be mentioned. From their great variety, the following shall serve as relevant examples :

Transport vehicles of all descriptions, especially those used for voluminous, protruding objects or cargoes having a high centre of gravity ; travelling cranes of all descriptions, with or without slewing superstructures ; chassis for transporting ships' hulls ; transporters for cannon, searchlights, wireless transmitters ; transporters for aerial masts ; with the chassis in the narrow-track position, the collapsed or folded aerial mast can be transported cross-country as needed ; after the chassis has been expanded, the mast is extended ; chassis for road-making machines, agricultural machines and soil tilling implements. In the last three cases the track variation of the chassis is used, among other purposes, for setting the machine or implement concerned for various working widths.

What we claim is :—

1. A vehicle chassis having a variable overall track comprising a chassis frame, at least two trucks whose positions relative to the frame can be altered to alter the overall track of the vehicle and of which the wheels form part of the complement of wheels on which the vehicle moves, and, for each truck, supporting means connecting the truck to the chassis frame and which can be adjusted to produce said alteration of the position of the truck relative to the chassis frame, each truck being connected to its corresponding supporting means in such a way that it can turn relatively to its supporting means about a vertical axis.

2. A vehicle chassis as claimed in Claim 1 in which each truck can turn relatively to its corresponding supporting means through 360° about a vertical axis.

3. A vehicle chassis as claimed in either of the preceding claims in which each truck is fitted to its corresponding supporting means by a floating axle, a swing axle or the like.

4. A vehicle chassis as claimed in any of the preceding claims in which each truck is provided with a reversible steering unit whereby the orientation of the truck relative to the corresponding supporting means can be adjusted.

5. A vehicle chassis as claimed in Claim 4 in which the steering unit is such as to lock the position of the truck relative to the corresponding supporting means when the relative orientation of the truck is not being adjusted.

6. A vehicle chassis as claimed in either of Claims 4 and 5 in which each truck is provided with a unit for driving the steering unit that is formed as an integral part of the truck.

7. A vehicle chassis as claimed in any of the preceding claims in which any of the said trucks is provided with a driving unit that is formed as an integral part of the truck.

8. A vehicle chassis as claimed in any of the preceding claims in which there are no more than two trucks whose positions relative to the chassis frame are adjustable and the vehicle is supported by said trucks and a third unit including at least one driven and steerable wheel whose position relatively to the chassis frame is fixed.

9. A vehicle chassis as claimed in any of Claims 1-7 comprising an auxiliary drive means the position of which relatively to the chassis frame is fixed.

10. A vehicle chassis as claimed in any of the preceding claims in which each supporting means is an arm pivotally connected to the chassis frame so that the arm can be adjusted, to alter the position relative to the chassis frame of the truck connected to it, by being rotated about an axis perpendicular to its length.

11. A vehicle chassis as claimed in Claim 10 in which the arm is hollow and means for rotating the arm relatively to the chassis frame is mounted within the arm.

12. A vehicle chassis as claimed in either of Claims 10 or 11 in which each truck is provided with two wheels each mounted on an individual axis and the trucks are steered by rotation of the arms with which they are associated.

13. A composite chassis comprising two vehicle chassis as claimed in any of the preceding claims connected together in the manner of a trailer-and-tractor.

14. A composite vehicle chassis comprising two vehicle chassis as claimed in any of Claims 1-12 connected together by a bridge member, the bridge member being connected to each chassis by means of a universal joint.

15. A composite chassis as claimed in Claim 14 when dependent upon any of Claims 10-12 in which each component chassis is provided with two pairs of trucks and the bridge member passes between the

trucks of one pair, the length of each of the supporting arms by means of which the latter pair of trucks is connected to the corresponding chassis frame being less than the separation between the two chassis frames.

16. A vehicle chassis as claimed in any of the preceding claims in which any of the supporting means is adapted to be fitted with counterweight.

17. A vehicle chassis substantially as described with reference to and as illustrated by any of the accompanying drawings.

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Fig. 1

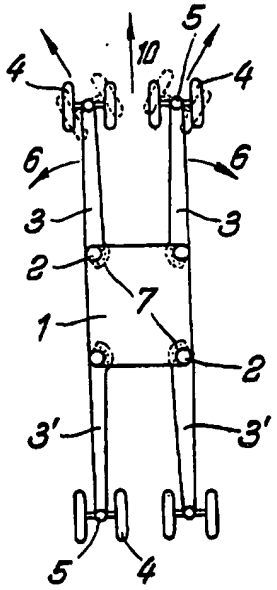


Fig. 2

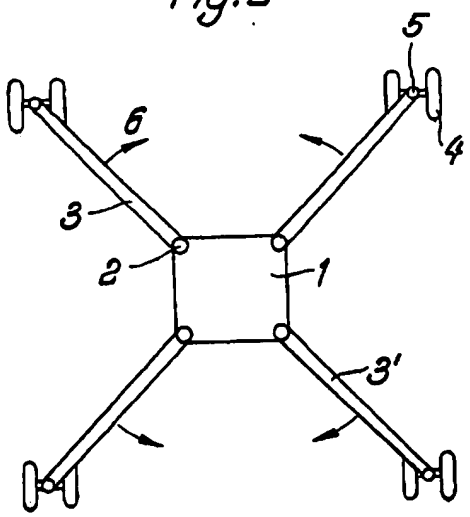


Fig. 4

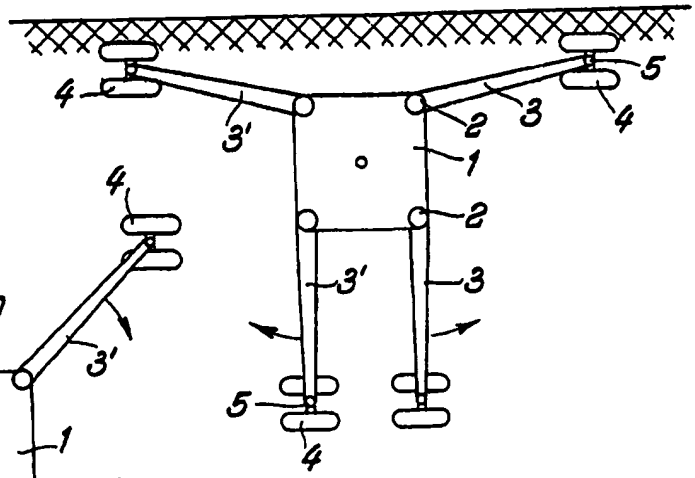


Fig. 3

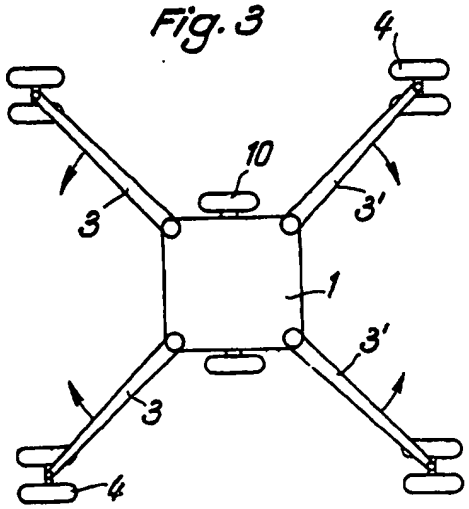


Fig. 5

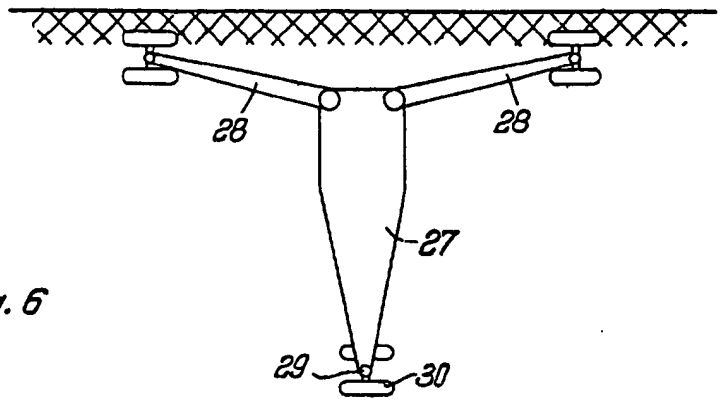


Fig. 6

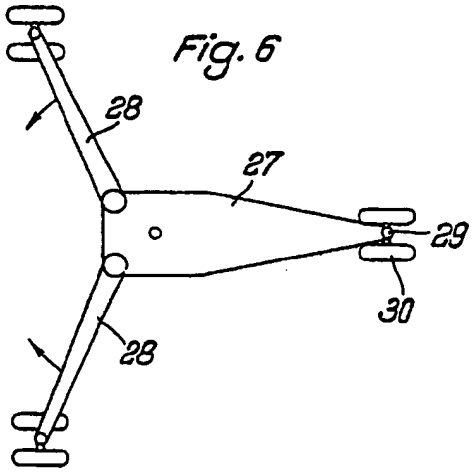


Fig. 7

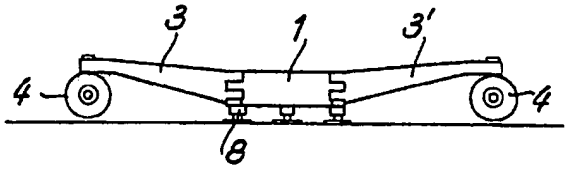
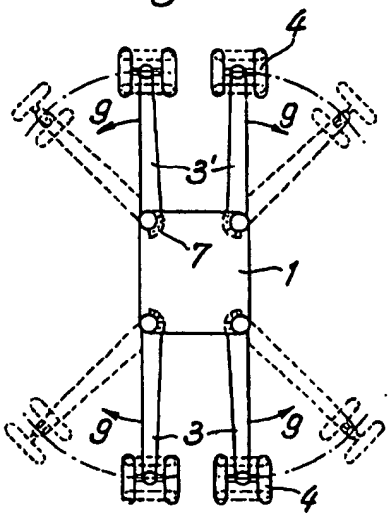


Fig. 8



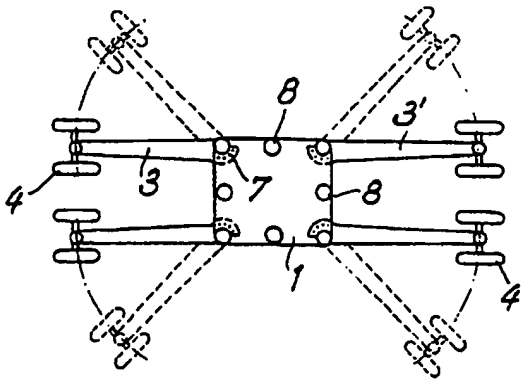


Fig. 7a

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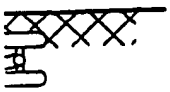


Fig. 9

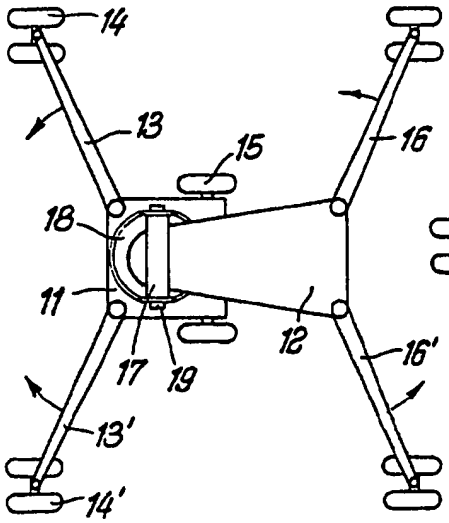
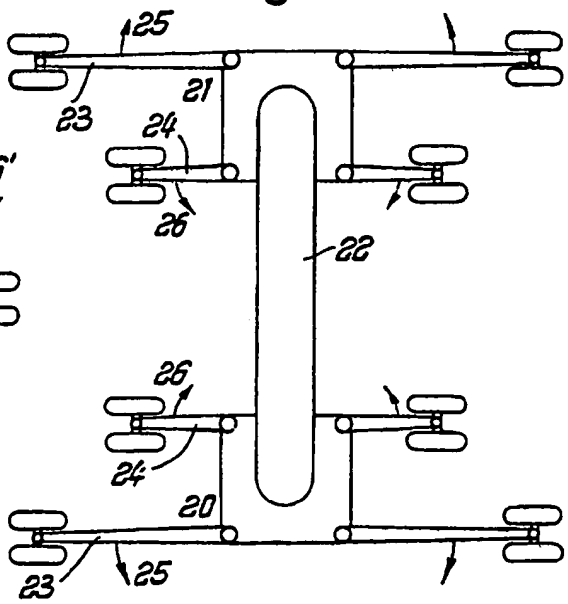


Fig. 10



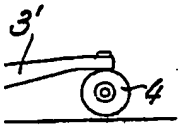
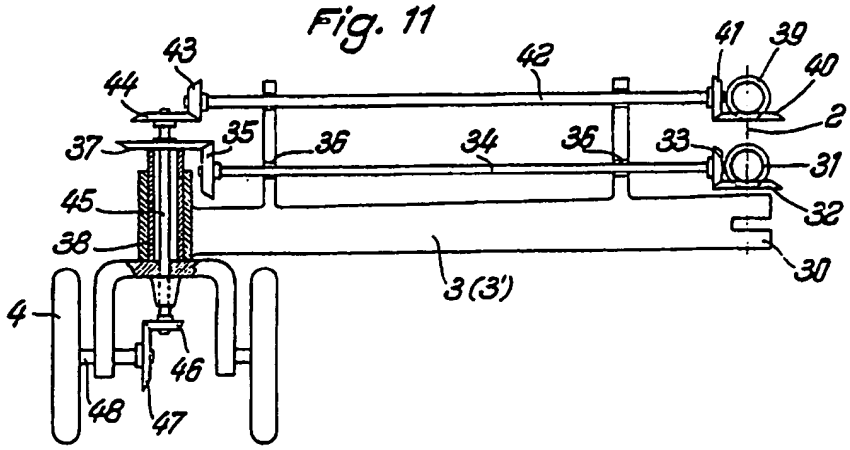


Fig. 11



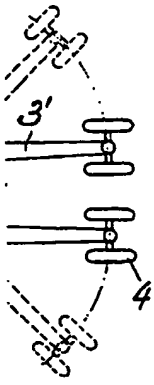


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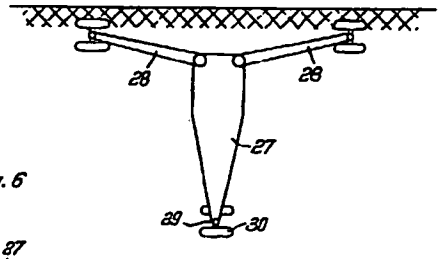
Fig. 5



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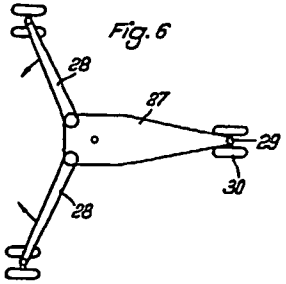


Fig. 7

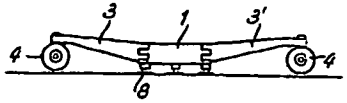
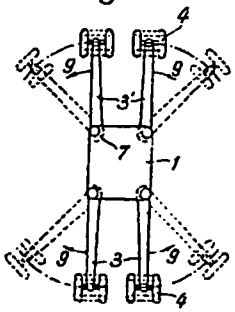


Fig. 8



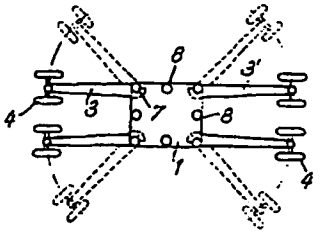


Fig. 7a

Fig. 9

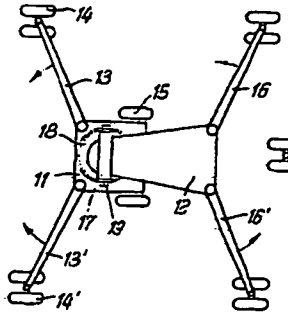


Fig. 10

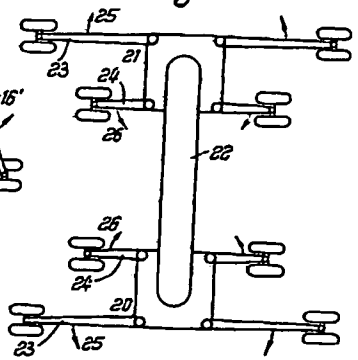


Fig. 11

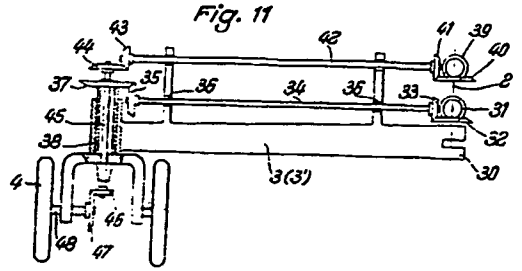


Fig. 12

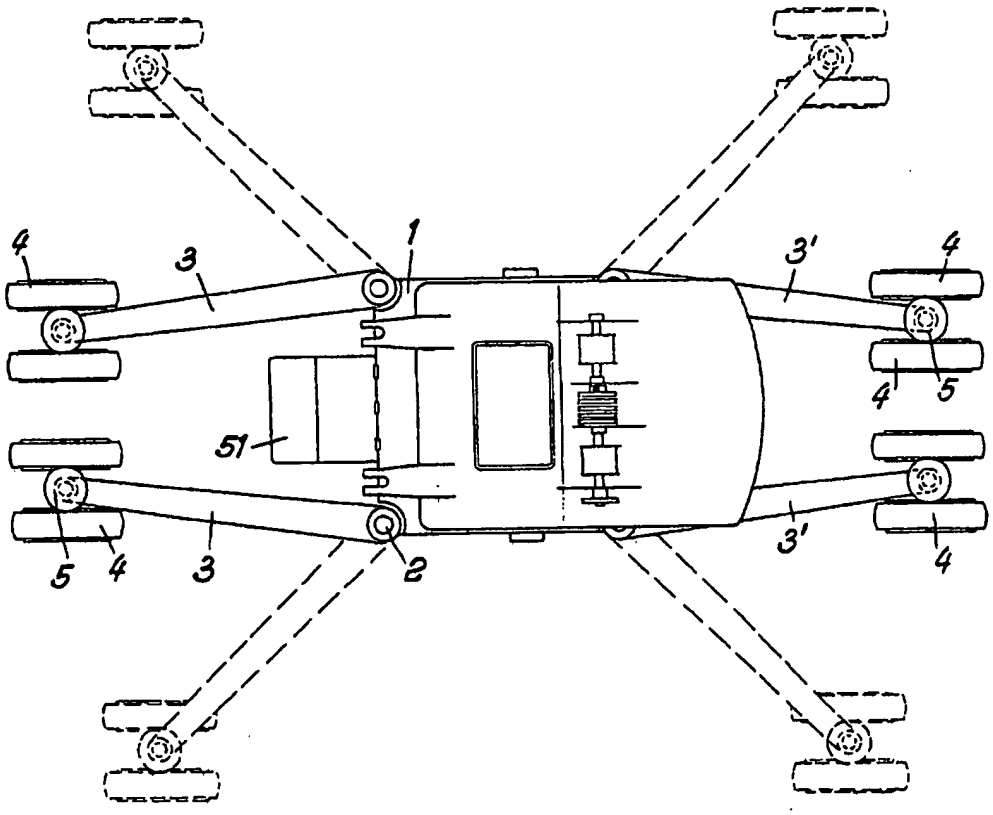


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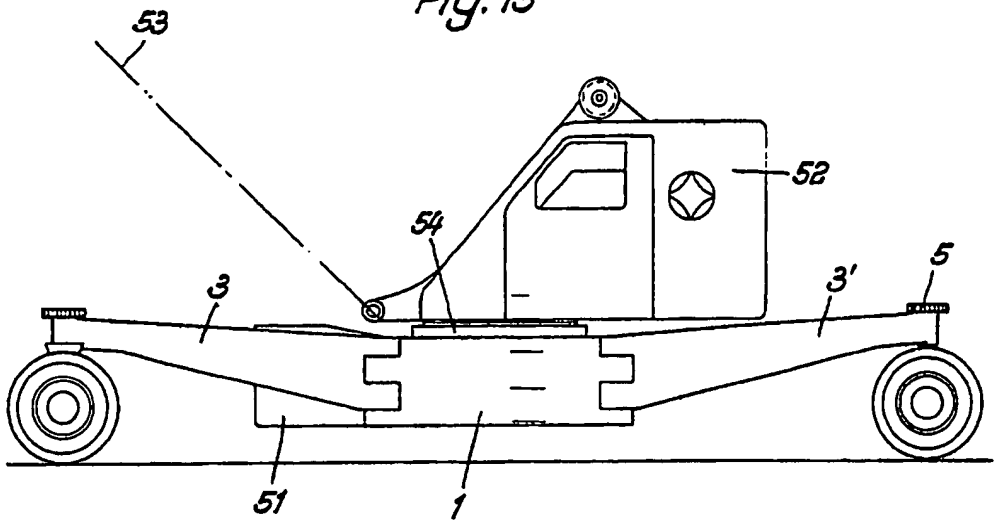
Fig. 13



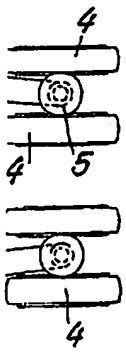


Fig. 14

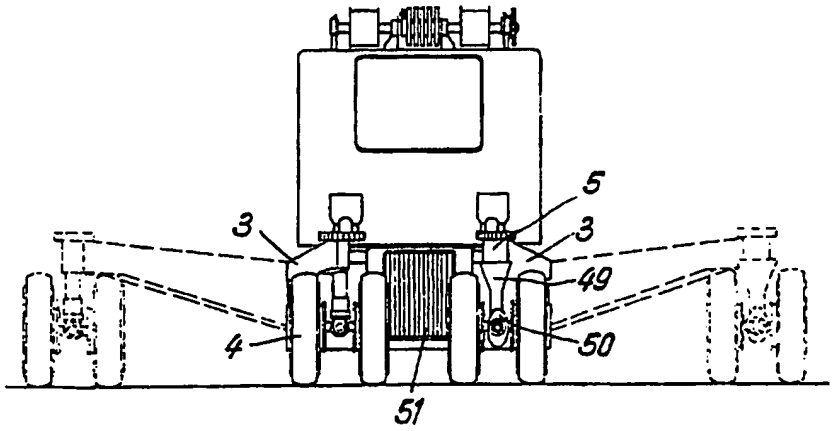


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Fig. 12

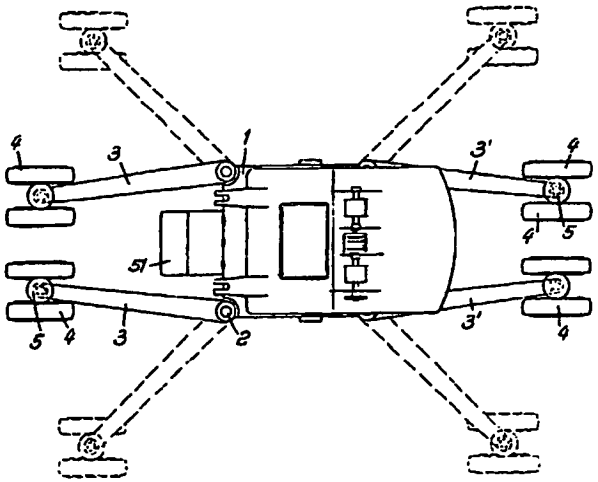

Fig. 13

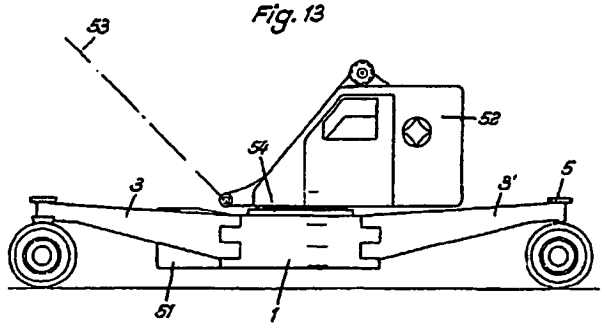

Fig. 14